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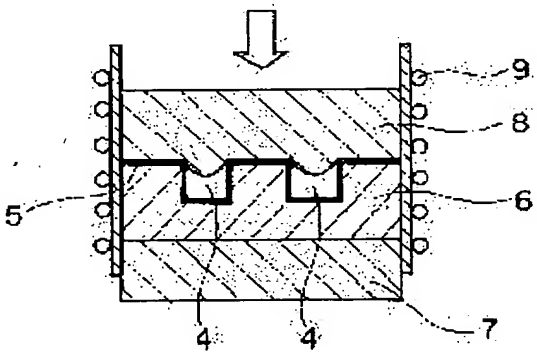
(54) MOLD FOR MICRO PART AND METHOD FOR MANUFACTURING THE SAME

(57)Abstract:
PROBLEM TO BE SOLVED: To provide a mold for a micro part low in production cost, having high accuracy and capable of withstanding repeated use or highly accurate processing such as extrusion molding or the like because of its high surface hardness, and a method for manufacturing the same.
SOLUTION: The master mold 6 of the mold for the micro part is prepared by processing the surface of an Si substrate and a hard film comprising a TiN film 5 is subsequently formed on the surface of the master mold 6. Then, the master mold 6 is transferred, for example, to a Ti-4.5Al-3V-2Fe-2Mo alloy having super-plasticity.



* NOTICES *

CLAIMS

[Claim(s)]
[Claim 1] Carry out spreading formation of the photoresist film on a glass substrate, and optical disk original recording with a detailed concavo-convex pattern is obtained on the photoresist film through processes, such as laser exposure and development. In the manufacture approach of La Stampa which obtains La Stampa for optical disk shaping by electroforming the-izing film as cathode next, the front face of this optical disk original recording -- a conductor -- the-izing film -- forming -- this -- a conductor -- said conductor -- the manufacture approach of optical disk La Stampa characterized by forming the mold release layer which consists of an organic fluorine compound through siloxane association on this oxide film after [the metallic conductor-ized film which adjoins an oxide film and this in the-izing film] considering as two-layer structure at least and exfoliating La Stampa from said original recording further.
[Claim 2] said conductor -- the manufacture approach of optical disk La Stampa according to claim 1 characterized by setting to at least 100nm or more thickness of said oxide film which constitutes the-izing film.
[Claim 3] said conductor -- the manufacture approach of optical disk La Stampa according to claim 1 characterized by using as the same element the metallic element of the metallic conductor-ized film which adjoins the metallic element which constitutes said oxide film, and this in the process which forms the-izing film, and considering both interface as an inclination presentation further.
[Claim 4] said conductor -- the manufacture approach of optical disk La Stampa according to claim 1 characterized by making Cr 2O3 and the adjoining metallic conductor-ized film into the two-layer structure of Cr and nickel for said oxide film in the process which forms the-izing film.
[Claim 5] The manufacture approach of optical disk La Stampa according to claim 1 characterized by carrying out vacuum evaporationo processing of the organic fluorine compound in the process which forms the mold release layer which consists of said organic fluorine compound after activating said oxide-film front face by the ion beam exposure of water.
[Claim 6] said conductor -- the oxide film which constitutes the-izing film -- Cr 2O3 it is -- said oxide film Cr 2O3 The manufacture approach of optical disk La Stampa according to claim 1 characterized by carrying out chemisorption processing of the organic fluorine compound after carrying out UV irradiation, heating a front face.
[Claim 7] Said oxide film Cr 2O3 The manufacture approach of optical disk La Stampa according to claim 6 characterized by heating a front face by infrared exposure.
[Claim 8] The fixture for manufacture of optical disk La Stampa which is the fixture used for the process which forms the mold release layer which consists of an organic fluorine compound of the manufacture approach of optical disk La Stampa according to claim 6, supports La Stampa in the periphery section of a rear face and a front face, supplies organic fluorine compound adsorption treatment liquid to the space formed with the La Stampa front face and said periphery section support fixture, and performs this organic fluorine compound processing only on the La Stampa front face.

[Claim 9] La Stampa for [redacted]al disk molding characterized by bein[redacted]nufactured by the manufacture approach ac[redacted]ding to claim 1 to 7.
[Claim 10] The optical disk characterized by being manufactured using La Stampa for optical disk molding according to claim 9.

[Translation done.]

* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention especially relates to La Stampa for optical disk molding, its manufacture approach, and an optical disk about La Stampa for molding of an information record medium, its manufacture approach, and an information record medium.
[0002]
[Description of the Prior Art] As an approach of manufacturing La Stampa for optical disk molding, conventionally Spreading formation of the photoresist film 2 is carried out on a glass substrate 1 like drawing 5 . The optical disk original recording 3 with a detailed concavo-convex pattern is created on the photoresist film through processes, such as laser exposure and development. Next, the method of manufacturing La Stampa 61 is common by exfoliating what formed the metallic conductor-ized film 4, such as nickel (nickel), in the front face of this optical disk original recording 3, electroformed this as cathode and formed nickel electrocasting film 5 from original recording 3. An optical disk uses for injection-molding metal mold La Stampa 61 obtained by doing in this way, and is manufactured.
[0003] In the above-mentioned conventional method, the trouble which a resin cast cannot release from mold good from La Stampa at the time of molding of an optical disk had occurred. That is, configurations, such as a signal pit and a guide rail, were not faithfully reversed to a cast, or the configuration of a signal pit or a guide rail collapsed further, or it lapped with other signal parts in the shape of a ghost, was formed in them, and the defective which cannot write a signal normally was generated. Since the detailed shape of much toothing, such as a signal pit, exists in the La Stampa front face, this cause is because it will be in a kind of fitting condition, when resin flows into these concave heights. Moreover, by cooling, between such [as a result] the fitting sections, compressive stress will work and a cast will act as mold release resistance, in order to contract more than La Stampa. Although these are based on a mainly physical operation, the low-molecular constituent of resin etc. adheres to the La Stampa front face gradually with shaping of long duration, and the chemical saying because these sticking firmly with a cast and suiting operation is also considered.
[0004] On the other hand, in order to raise informational recording density in these days, it is in the inclination for dimensions, such as a signal pit of an optical disk and a guide rail, to become still smaller. For example, the guide rail pitch of DVD for outputting and inputting a lot of digital images is 0.76 micrometers (the conventional CD 1.2 micrometers). In such an optical disk, since the fitting section with minute La Stampa and resin substrate increases and the substantial surface area which La Stampa and resin touch in addition also increases, good mold release which does not give a blemish to a cast is becoming still more difficult.
[0005] Then, the technique which forms molecular films, such as an organic fluorine compound, as a mold release layer on the surface of La Stampa is indicated in order to improve above poor mold release. For example, in JP,8-147769,A or JP,8-18336,B, it is fluoro alkyl silane SiCln X3-n as first amelioration technique. By chemisorption, it is -CF3 to a front face. The plastic-molding metal mold to which orientation of the monomolecular film with a radical was carried out is proposed.
[0006] Moreover, after forming an oxide in the La Stampa front face in order to combine firmly with La Stampa the organic fluorine compound which is mainly a mold release layer as second

amelioration technique, t[redacted]metal mold to which the fluoro alkyl si[redacted]was made to stick is indicated by JP,6-10361[redacted].

[0007]

[Problem(s) to be Solved by the Invention] The KURORU silane which has Cl on a hydrolysis radical with said first amelioration technique is SiCln X3-n and alkoxysilane Si(OCm H2m+1) n X3-n. Although the merit which can carry out orientation of the molecular film is in high density more firmly [the reactivity on the front face of an inorganic substance is high, and], since a hydrochloric acid HCl was generated in a reaction process, there was a problem that adaptation was difficult in common iron system metal mold.

[0008] Although the corrosion resistance of extent which is the metal mold which makes a metal like nickel a subject on the other hand was expectable, since in the case of La Stampa it became a fatal defect of shape even if the concave configuration more than a signal pit and equivalent size is formed of pitting, application of the KURORU silane to La Stampa was impossible in practice.

[0009] Furthermore, with said second amelioration technique, in order not to change the pit configuration of La Stampa a lot, as for the thickness of the oxide which forms membranes, several 10nm is considered to be a limitation. In the case of such a thin oxide, the film had the fault of it being comparatively weak dynamically since it is island-like structure, and exfoliating the whole fluorine compound mold release layer formed in the upper part from the interface of nickel side of La Stampa, and an oxide by the injection pressure at the time of molding, contact to melting resin, the deformation behavior of La Stampa accompanying them, etc. That is, there was a fault that the adhesion reinforcement of the oxide layer in which the organic fluorine compound mold release layer was formed was inadequate.

[0010] This invention was made in order to solve the trouble in the above conventional techniques, and it aims at offering La Stampa for optical disk molding with a good mold-release characteristic, its manufacture approach, and an optical disk with a cast.

[0011]

[Means for Solving the Problem] The manufacture approach of optical disk La Stampa which starts this invention in order to solve said technical problem Carry out spreading formation of the photoresist film on a glass substrate, and optical disk original recording with a detailed concavo-convex pattern is obtained on the photoresist film through processes, such as laser exposure and development. In the manufacture approach of La Stampa which obtains La Stampa for optical disk shaping by electroforming the-izing film as cathode next, the front face of this optical disk original recording -- a conductor -- the-izing film -- forming -- this -- a conductor -- said conductor -- after [the metallic conductor-ized film which adjoins an oxide film and this in the-izing film] considering as two-layer structure at least and exfoliating La Stampa from said original recording further, it is characterized by forming the mold release layer which consists of an organic fluorine compound through siloxane association on this oxide film.

[0012] According to the aforementioned configuration, chemisorption (covalent bond) is carried out with high density [the silane system compound which has the functional groups Y, such as an alkoxy group the Krol radical a cyano group, an isocyanato group, and an amino group,], and firmly, and a good mold release layer is formed. And since the oxide film is formed beforehand, manufacture of La Stampa of a good signal quality faithful to the pit configuration of original recording is attained.

[0013] the manufacture approach of optical disk La Stampa concerning this invention -- said conductor -- it is characterized by setting to at least 100nm or more thickness of said oxide film which constitutes the-izing film. According to the aforementioned configuration, since thickness is thick enough, while oxide-film structure becomes precise, adhesion and a mechanical strength are improved, and the adsorption active spot of a silane compound is further formed by high density.

[0014] the manufacture approach of optical disk La Stampa concerning this invention -- said conductor -- in the process which forms the-izing film, it is characterized by using as the same element the metallic element of the metallic conductor-ized film which adjoins the

metallic element which c[redacted]itutes said oxide film, and this, and co[redacted]lering both interface as an inclination presentatio[redacted]rther. According to the aforementione[redacted]onfiguration, the adhesion force of an oxide film is high, therefore the manufacture of La Stampa with high endurance without omission from a boundary part etc. is attained.

[0015] the manufacture approach of optical disk La Stampa concerning this invention -- said conductor -- in the process which forms the-izing film, it is characterized by making Cr 2O3 and the adjoining metallic conductor-ized film into the two-layer structure of Cr and nickel for said oxide film. According to the aforementioned configuration, Cr of the two-layer structures is an oxide film Cr 2O3. Since good adhesion is maintained, and nickel has good adhesion with the lower layer Cr and an oxide film cannot remain easily, adhesion with a electrocasting layer is improved and manufacture of La Stampa with high endurance is attained.

[0016] In the process which forms the mold release layer which consists of said organic fluorine compound, after the manufacture approach of optical disk La Stampa concerning this invention activates said oxide-film front face by the ion beam exposure of water, it is characterized by carrying out vacuum evaporationo processing of the organic fluorine compound. According to the aforementioned configuration, the adsorption active spot of the silane compound at the time of forming the mold release film is formed by high density, it excels in the mold release effectiveness, and La Stampa with high endurance becomes possible.

[0017] the manufacture approach of optical disk La Stampa concerning this invention -- said conductor -- the oxide film which constitutes the-izing film -- Cr 2O3 it is -- said oxide film Cr 2O3 After carrying out UV irradiation, heating a front face, it is characterized by carrying out chemisorption processing of the organic fluorine compound. According to the aforementioned configuration, formation of precise Cr oxide film is attained by the front face.

[0018] The manufacture approach of optical disk La Stampa concerning this invention is said oxide film Cr 2O3. It is characterized by heating a front face by infrared exposure. Since there is no heater part heated directly according to the aforementioned configuration, defective generating of La Stampa by generating of particle is eliminated.

[0019] The fixture for manufacture of optical disk La Stampa concerning this invention is a fixture used for the process which forms the mold release layer which consists of an organic fluorine compound of the manufacture approach of aforementioned optical disk La Stampa, and is characterized by to support La Stampa in the periphery section of a rear face and a front face, to supply organic fluorine compound adsorption treatment liquid to the space formed with the La Stampa front face and said periphery section support fixture, and to perform this organic fluorine-compound processing only on the La Stampa front face. It becomes possible to make a mold release layer form only in the La Stampa front face, without according to the aforementioned configuration, exposing the rear face of La Stampa to the processing liquid containing an acid, and making it corrode.

[0020] La Stampa for optical disk molding concerning this invention is characterized by being manufactured by said manufacture approach. -CF3 of the mold release film by which orientation was carried out to the front face according to the aforementioned configuration A radical bars adhesion of other matter and, therefore, a good mold-release characteristic is realized. Thus, the product percent defective accompanied by poor mold release decreases, and long La Stampa of useful life longevity is realized.

[0021] The optical disk concerning this invention is characterized by being manufactured using aforementioned La Stampa for optical disk molding. According to the aforementioned configuration, by being fabricated by good La Stampa of a mold-release characteristic, deformation of the signal pit configuration at the time of mold release is avoided, and the optical disk of the shape of surface type which imprinted the signal pit configuration of original recording faithfully is obtained.

[0022]

[Embodiment of the Invention] the conductor which serves as cathode in the case of electrocasting in this invention in order to solve the trouble of the above conventional methods -- after [an oxide film to be combined with the degree of high nectar and for an

organic fluorine compound the-izing film to the front face firmly siloxane association, and the metallic conductor-ized film which adjoins this] consider a two-layer structure at least and exfoliating La Stampa from original recording, it is characterized by to form the mold-release layer which consists of said organic fluorine compound on this oxide film. According to such a manufacture approach, the mold release layer which consists of an organic fluorine compound can be formed on the oxide film which has sufficient thickness, a mechanical strength, and adhesion, and La Stampa which moreover reversed the signal pit configuration of original recording etc. very faithfully can be obtained. Hereafter, the detail of this invention is explained based on an operation gestalt.

[0023] Example 1 drawing 1 is a type section Fig. explaining the manufacture approach of La Stampa by this invention. As shown in this drawing, spreading formation of the photoresist film 2 is carried out on a glass substrate 1, and the optical disk original recording 3 with a detailed concavo-convex pattern is created on the photoresist film 2 through processes, such as laser exposure and development. Next, 100nm of nickel oxides 7 (NiO) was formed by the reactant spatter, and 50nm of metallic conductor-ized film 4 of nickel was continuously formed in the front face of this optical disk original recording 3. Membranes are formed reducing the partial pressure of oxygen gas gradually, and it was made for a clear interface not to exist in the nickel oxide 7 and the metallic conductor-ized film 4 at this time.

[0024] Next, nickel electrocasting was performed by having used the metallic conductor-ized film 4 as cathode, this was further exfoliated from the interface of the photoresist film 2 and the nickel oxide 7, and La Stampa 6 was obtained.

[0025] Next, in order to remove the residual component of the photoresist film 2 which exists slightly on La Stampa 6, the La Stampa front face was exposed to the bottom of ozone or active oxygen with UV Usher equipment which is not illustrated, and the surface residual organic substance was removed.

[0026] Drawing 2 is a whole block diagram explaining the manufacture approach of La Stampa by this invention. As shown in drawing 2 , after it introduced La Stampa 6 vacuum chamber 11 and it carried out vacuum suction following the above, the ion beam of water was irradiated, and La Stampa 6 front face was activated. The ion irradiation conditions at this time were set to amount of ion irradiation 1x1014 ions/cm2, and acceleration voltage 300v. By the ion beam exposure of water, the chemisorption active spot of the hydroxyl group, i.e., the organic fluorine compound in degree process, firmly combined with the front face of the oxide film 7 of La Stampa by the chemical bond can be formed in high density.

[0027] Next, the exposure of an ion beam was stopped and the mold release layer of an organic fluorine compound was formed with the vacuum deposition method. That is, electron beam heating of the vacuum evaporationo source 8 which made metal souls, such as inorganic substance powder and steel wool, fix the fluoro alkyl silane (OR) SiX 3 (for X to be a fluoro alkyl group and for OR to be an alkoxy group) was carried out within the vacuum chamber 11, and the silane was vapor-deposited to La Stampa 6 which counters. More specifically, it is fluoro alkyl silane CF3 7 (CF2) CH2 CH2 Si (OCH3)3. It used.

[0028] In addition, CF3 5 (CF2) CH2 CH2 Si (OCH3)3, CF3 3 (CF2) CH2 CH2 Si (OCH3)3, CF3 7 (CF2) CH2 CH2 Si (OC two H5)3 etc. -- fluoro alkyl silane SiXn Y3-n which has the functional groups Y, such as alkoxysilane, the Krol radical and a cyano group, an isocyanato group, and an amino group, etc. -- it can use. These fluoro alkyl silanes form association in an inorganic substance front face for the hydroxyl group and chemical reaction on the front face of an inorganic substance firmly by the lifting and siloxane joint O-Si-O.

[0029] The cross section of La Stampa obtained as mentioned above is shown in drawing 3 . Especially in this drawing, for convenience, although the part of the mold release layer 12 is expanded and drawn, the thickness of the actual mold release layer 12 is several nm order. Moreover, although the interface of an oxide film 7 and the metallic conductor-ized film 4 is an inclination presentation, simple [of it] is carried out by a diagram, and it is drawn on two-layer.

[0030] Optical disk La Stampa by this invention is -CF3 to a front face. It has the mold release layer 12 in which the radical carried out orientation. - CF3 Because of the high

electronegativity of a flu[redacted], fluorocarbon like a radical has the l[redacted] binding energy between C-F, and it is very stable chemically. That is, other matter does not adhere in chemical bond. Moreover, since it has only a weak interaction extremely between molecules to strong association of such intramolecular, there are no physical adsorption and adhesion of other matter, and good lubricity is discovered. From such a surface characteristic, optical disk La Stampa by this invention has a very good mold-release characteristic.

[0031] When injection molding of an optical disk was performed using this La Stampa, poor mold release from which even shaping of about 100,000 sheets poses a problem was not generated (methacrylic resin, the cylinder temperature of 260 degrees C, die temperature of 60 degrees C).

[0032] In example 2 example 1, 100nm (Cr 2O3) of Cr oxides was formed in the front face of optical disk original recording by the reactant spatter, 20nm of Cr metallic conductor-ized film was continuously continued further on it, and 30nm of nickel metallic conductor-ized film was formed in it. The interface of Cr oxide film and Cr metallic conductor-ized film as well as an example 1 is made the inclination presentation. This was exfoliated from the interface of the photoresist film and Cr oxide film after electrocasting, and La Stampa was obtained.

[0033] Next, when defecating this La Stampa with UV Usher equipment, processing of 2 hours was performed, heating at 200 degrees C by infrared heating. By heating La Stampa, irradiating UV at the Usher process, a precise oxide film is formed of a front face by the oxidation of the annealing effectiveness, ozone, or active oxygen. With a precise oxide film, the fluorine compound adsorption active spot of high density is obtained more, and the corrosion resistance of La Stampa over the hydrochloric acid generated at the following KURORU silane wet adsorption treatment process in coincidence can be improved even on satisfactory level. Moreover, since the heating approach using infrared radiation does not have a direct heating unit like a heater, it does not have generating of particle, and it does not cause the point defect to La Stampa etc.

[0034] Next, formation of an organic fluorine compound mold release layer was performed using the fixture shown in drawing 4 R> 4. La Stampa 6 is supported from the rear face with the processing fixture made from Teflon (the side fixture 15, presser-foot plate 13), and forms the liquid reservoir space for holding silanizing liquid 16 in the La Stampa front-face side which has a signal pit with the side fixture 15. Since Electrocasting nickel has exposed the rear face of La Stampa 6, the seal is made with O ring 14 so that it may not be exposed to silanizing liquid 16.

[0035] After attaching La Stampa in a fixture like drawing 4 under heating UV irradiation, silanizing liquid was supplied to liquid reservoir space in the nitrogen-purge ambient atmosphere. What diluted fluoro alkylchlorosilane CF3 7 (CF2) CH2 CH2 SiCl3 and 10mM to the perfluoro hexane was used for silanizing liquid. Immersion time amount was made into 1 hour at the room temperature. Next, in order to remove the silane physisorbed too much, after washing La Stampa 6 and carrying out rocking washing lightly in pure water further by the perfluoro hexane, it was made to dry by nitrogen blow. Thus, obtained La Stampa had the good mold-release characteristic like the example 1.

[0036] Although the KURORU silane was used in this example, the above-mentioned alkoxysilane can also be used. In this case, baking of 1 hour is performed at 150 degrees C after desiccation using the processing solution which added acids, such as a hydrochloric acid and an acetic acid, as a hydrolysis catalyst. According to this approach, a mold release layer can be stably formed also to such a treatment process that contains an acid beforehand.

[0037]

[Effect of the Invention] Fluoro alkyl silane SiXn Y3-n which has the functional groups Y, such as an alkoxy group, the Krol radical, a cyano group, an isocyanato group, and an amino group, since the oxide film is formed in the La Stampa front face when releasing from mold from original recording by the manufacture approach of optical disk La Stampa concerning claim 1 of this invention as explained in full detail above Chemisorption (covalent bond) can be carried out with high density and firmly, and a good mold release layer can be formed in a La Stampa maximum front face. And since it was formed beforehand, after this oxide film released La

Stampa from mold from [redacted]onventional original recording, compa[redacted]with what forms these, it had reversed the pit configuration of original recording more faithfully, and was able to obtain good La Stampa of a signal quality. By La Stampa by this manufacture approach, the product percent defective accompanied by poor mold release was able to be reduced, and the useful life longevity of La Stampa by a resin affix etc. was able to be sharply prolonged to coincidence.

[0038] the manufacture approach of optical disk La Stampa concerning claim 2 of this invention -- a conductor -- since the thickness of the oxide film which constitutes the-izing film is as thick enough as 100nm or more, while an oxide film takes precise membrane structure and is excellent in the own adhesion and own mechanical strength of an oxide film, it becomes possible to give the adsorption active spot of the silane compound at the time of forming the mold release film by high density.

[0039] By the manufacture approach of optical disk La Stampa concerning claim 3 of this invention, the metallic element of the metallic conductor-ized film which adjoins the metallic element which constitutes this oxide film, and this is the same element, since both interface serves as an inclination presentation further, the adhesion force of an oxide film is high, therefore there are no omission from these boundary parts etc., and La Stampa with the high endurance of the mold release effectiveness can be obtained.

[0040] the manufacture approach of optical disk La Stampa concerning claim 4 of this invention -- a conductor -- the oxide film which constitutes the-izing film -- Cr 2O3 it is -- since -- since a more precise scaling layer is formed of the ozone in the following UV Usher process, or the oxidation of active oxygen -- a silane compound -- high density -- and it can form firmly and La Stampa with high mold release effectiveness and its endurance can be offered. Moreover, Cr among the metallic conductor-ized film used as two-layer structure is said oxide film Cr 2O3. Since it has good adhesion, and nickel has good adhesion with the lower layer Cr and the detrimental oxidation film cannot remain easily as cathode in the case of electrocasting, good adhesion with a electrocasting layer is given. Therefore, there are no omission from these boundary parts etc., and La Stampa with the high endurance of the mold release effectiveness can be obtained.

[0041] By the manufacture approach of optical disk La Stampa concerning claim 5 of this invention, since an oxide-film front face is activated by the ion beam exposure of water, the adsorption active spot of the silane compound at the time of forming the mold release film can be given by high density. Thereby, it excels in the mold release effectiveness and La Stampa with high endurance can be offered.

[0042] the manufacture approach of optical disk La Stampa concerning claim 6 of this invention -- a conductor -- the oxide film which constitutes the-izing film -- Cr 2O3 it is -- chemisorption processing of the organic fluorine compound to this oxide-film top -- hitting -- Cr 2O3 In order to carry out UV irradiation, heating a front face, a precise oxide film is formed of a front face. Although an acid etc. is generally easy to be invaded if it remains as it is since not only a reactant spatter but a thin film [having formed membranes] includes many defects, according to this approach, very precise Cr oxide is formed in the La Stampa front face of the oxidation by the annealing effectiveness by heating, ozone, or active oxygen. To a silane which generates an acid in a reaction process like a KURORU silane by this, and a silane like alkoxysilane which adds and uses acids, such as a hydrochloric acid and an acetic acid, as a hydrolysis catalyst beforehand, a cheaper wet process can be developed compared with the vacuum forming-membranes method, and, moreover, the mold release film can be formed stably.

[0043] the manufacture approach of optical disk La Stampa concerning claim 7 of this invention -- a conductor -- oxide film Cr 2O3 which constitutes the-izing film Since it heats by infrared exposure, there is no heater part heated directly and defective generating of La Stampa by generating of particle can be eliminated. Moreover, energy can be easily supplied to existing UV Usher equipment from the outside using optical system, such as a mirror.

[0044] The manufacture fixture of optical disk La Stampa concerning claim 8 of this invention can make a mold release layer form only in the La Stampa front face, without exposing the

rear face of La Stampa to [redacted] processing liquid containing an acid, [redacted] making it corrode, in order to supply silane adsorption treatment liquid only to the space which supports La Stampa in the periphery section of a rear face and a front face, and is formed with the La Stampa front face and this periphery section support fixture.

[0045] Optical disk La Stampa concerning claim 9 of this invention is -CF3 to a front face. Since it has the mold release film in which the radical carried out orientation, it does not adhere [that other matter is chemical and] firmly physically, and a very good mold-release characteristic can be realized. And after releasing La Stampa from mold from the conventional original recording, compared with what formed these, the pit configuration of original recording is reversed more faithfully and it has a good signal quality. It becomes possible by reducing the product percent defective accompanied by poor mold release, and eliminating affixes, such as resin, to coincidence by La Stampa by this invention, to prolong the useful life longevity of La Stampa sharply.

[0046] Since the shape of surface type which a signal pit configuration etc. did not change at the time of mold release, therefore imprinted very faithfully the signal pit configuration of optical disk original recording etc. since it was fabricated by good La Stampa of a mold-release characteristic is acquired, the optical disk concerning claim 10 of this invention does so the effectiveness that the optical disk which has the stable regenerative-signal quality which is not in the former is obtained.

[Translation done.]

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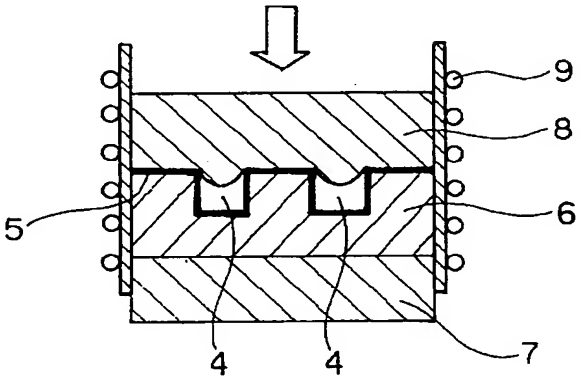
(54)【発明の名称】　マイクロ部品用金型およびその製造方法

(57)【要約】
【課題】　製造コストが安価で且つ高い精度を有し、しかも表面の硬度が高いことから繰り返し使用や押出し成形等の高精度加工に耐え得るマイクロ部品用金型およびその製造方法を提供する。
【解決手段】　Ｓｉ基板の表面を加工することによってマイクロ部品用金型の原型６を調製し、次いで、原型６の表面にＴｉＮ膜５からなる硬質皮膜を形成し、そして、超塑性を有する、例えば、Ｔｉ－４．５Ａｌ－３Ｖ－２Ｆｅ－２Ｍｏ合金に、ＴｉＮ膜５を介して原型６を転写する。



【特許請求の範囲】
【請求項１】　表面に硬質皮膜が形成された、超塑性金属からなることを特徴とするマイクロ部品用金型。
【請求項２】　前記硬質皮膜は、傾斜分布組成を有することを特徴とする、請求項１記載のマイクロ部品用金型。
【請求項３】　前記硬質皮膜は、ＴｉＮからなり、前記ＴｉＮ濃度は、前記硬質皮膜の表層から内部に向って低下しており、前記超塑性金属は、Ｔｉ合金からなることを特徴とする、請求項１記載のマイクロ部品用金型。
【請求項４】　前記Ｔｉ合金は、Ａｌ：４から５%、Ｖ：２．５から３．５%、Ｆｅ：１．５から２．５%、Ｍｏ：１．５から２．５%（以上、Ｍａｓｓ%）、残部：実質的にＴｉからなることを特徴とする、請求項３記載のマイクロ部品用金型。
【請求項５】　前記硬質皮膜は、Al_2O_3からなり、前記Al_2O_3濃度は、前記硬質皮膜の表層から内部に向って低下しており、前記超塑性金属は、Ａｌ合金からなることを特徴とする、請求項１記載のマイクロ部品用金型。
【請求項６】　基板の表面を加工することによってマイクロ部品用金型の原型を調製し、次いで、前記基板との反応を阻止する硬質皮膜を前記原型の表面に形成し、そして、超塑性金属と前記皮膜とを拡散接合させることにより、前記超塑性金属に前記皮膜を介して前記原型を転写することを特徴とする、マイクロ部品用金型の製造方法。
【請求項７】　前記硬質皮膜の硬質形成物質の濃度を、前記基板表面から超塑性金属側に向けて低下させることを特徴とする、請求項６記載の、マイクロ部品用金型の製造方法。
【請求項８】　前記基板は、Ｓｉからなり、前記超塑性合金は、Ｔｉ合金からなり、そして、前記硬質形成物質は、ＴｉＮからなることを特徴とする、請求項７記載の、マイクロ部品用金型の製造方法。
【請求項９】　前記基板は、Ｓｉからなり、前記超塑性合金は、Ａｌ合金からなり、そして、前記硬質形成物質は、Al_2O_3からなることを特徴とする、請求項７記載の、マイクロ部品用金型の製造方法。
【請求項１０】　前記基板の表面に、フォトリソグラフィー法によって前記原型のレジストパターンを形成し、そして、前記レジストパターン以外の前記基板の表面部分をエッチングにより所定深さに除去することによって、前記原型を調製することを特徴とする、請求項６から９の内の何れか１つに記載の、マイクロ部品用金型の製造方法。
【請求項１１】　前記Ｔｉ合金は、Ａｌ：４から５%、Ｖ：２．５から３．５%、Ｆｅ：１．５から２．５%、Ｍｏ：１．５から２．５%（以上、Ｍａｓｓ%）、残部：実質的にＴｉからなることを特徴とする、請求項８または１０記載の、マイクロ部品用金型の製造方法。
【発明の詳細な説明】
【０００１】
【発明の属する技術分野】この発明は、製造コストが安価で且つ高い精度を有し、しかも表面の硬度が高いマイクロ部品用金型およびその製造方法に関するものである。
【０００２】
【従来の技術】マイクロ部品としては、例えば、以下のものがある。
【０００３】（１）回折格子を形成した分光デバイス
図１０に示すように、平面状に微細なピッチで回折格子を形成し、これに光を照射することによって、所定の回折条件を満たす光波長を分光するデバイスである。
【０００４】（２）エンコーダー用スケール
図１１に示すように、微細な凹凸が形成された平面状のスケールである。
【０００５】（３）フルネルレンズ
平面上にピッチを持った溝をレンズ状に形成し、平面方向からの光を平面と垂直な方向に取り出すものである。
【０００６】（４）マイクロレンズ
平面基板上に微細なレンズの集合体を形成し、光学上の一括位置合せを可能にするものであり、複眼レンズの製造も可能である。
【０００７】従来、上記マイクロ部品は、製品そのものを機械加工により直接切削加工することにより、あるいは、ガラスやシリコンにフォトリソ工程でパターニングおよびエッチングすることにより製造していた。
【０００８】しかしながら、例えば、上記分光デバイスの場合には、回折格子を機械加工するために、非常に高精度の加工機械と加工制御技術が必要とされ、加工に長時間を要することから、コストが高かった。この問題は、上記他のマイクロ部品でも同様であった。
【０００９】この他の製造方法として、マイクロ部品用金型を使用する方法もあった。この金型の製造方法には、以下のものがあった。
（１）製品金型そのものを機械加工により直接切削加工する方法
（２）ＬＩＧＡプロセス（Lithographie Galvanoformung Abfprmung）
（３）放電加工法
【００１０】
【発明が解決しようとする課題】しかしながら、上記各製造方法には、以下のような問題があった。
【００１１】（１）の機械加工による方法は、加工精度に問題があり、十分な加工精度を得るため、大型で高剛性の機械が必要であった。従って、金型製造コストが高かった。
【００１２】（２）のＬＩＧＡは、厚いレジストを形成し、その上に放射光を用いてパターニングし、そのレジ

ストパターンを電気めっき（電気鋳造）により複写して製造するものであるが、この方法は、放射光を照射する特殊で高価な設備を必要とする。また、製品金型は、電気めっきできる、例えば、金やニッケル等比較的柔らかい材料に限られる。

【００１３】（３）の放電加工法は、例えば、ＷＥＤＧ法と呼ばれる方法によって調製された電極を用い、金型の加工を行なう方法であるが、この方法は、電極の消耗が基本的な課題であり、長時間の加工では電極の交換を頻繁に行なわねばならず、精度が出にくい。また、電極の交換を行なった場合、膨大な金型製作費が要する。さらに、放電加工は、熱加工のために表面粗度が粗い。

【００１４】従って、この発明の目的は、製造コストが安価で且つ高い精度を有し、しかも表面の硬度が高いマイクロ部品用金型およびその製造方法を提供することにある。

【００１５】

【課題を解決するための手段】本発明者等は、上述を達成すべく、鋭意研究を重ねた結果、以下のような知見を得た。

【００１６】（１）Ｓｉ等の基板をフォトリソグラフィー法およびイオン照射等のエッチング法により加工して、マイクロ部品用金型の原型を調製し、そして、超塑性を有する金型用素材としてのＴｉ合金等に、この原型を転写すれば、マイクロ部品用金型を安価且つ高精度に製造することができるといった知見を得た。

【００１７】（２）しかし、さらに微細な凹凸の転写や、尖った角部の転写を行うには、超塑性材料の押し込みだけでは、転写精度に限界の有ることが分かった。これを解決するためには、上記転写に際し、Ｓｉ型の表面にスパッター等により、膜を生成させ、その後超塑性材料を押し込み、生成した膜と超塑性材料を一体とすることにより、超微細な型の転写が可能なことが分かった。

【００１８】（３）上記（１）の転写に際して、Ｔｉ合金とＳｉとの金属間化合物の生成を阻止するには、Ｓｉ製原型の表面に予め前記金属間化合物の生成阻止機能を有するSiO_2やＳｉＮ膜を形成しておくことが考えられるが、転写前にＳｉ製原型の表面にＴｉＮ膜を、傾斜分布組成、即ち、その深さ方向にＴｉＮ濃度が異なり、表層部分は実質的に純Ｔｉとなるように形成し、その後、Ｔｉ合金を押し込めば、高精度で微細構造の転写が可能となり、しかも、Ｔｉ合金と純Ｔｉとは拡散接合性に優れることから、Ｔｉ合金とＴｉＮ膜とは拡散接合により強固に接合する。この結果、表面に高硬度のＴｉＮ膜が形成された、繰り返し使用や押出し成形等の加工に耐え得るＴｉ合金製金型が得られる。しかも、超塑性加工条件と拡散接合条件とは重複するので、転写と拡散接合が一工程で行なえるといった知見を得た。

【００１９】なお、上記超塑性とは、ある条件下で金属材料がくびれ（necking）なしに数百％から千％、時には、千％超の巨大な伸びを生じる現象である。従って、ある特定の温度域で塑性加工を加えることにより超塑性現象を発現させれば、金属材料が溝内の細部まで入り込む結果、原型に忠実なレプリカの製造が可能となる。超塑性を有する金属材料については、発明の実施の形態の項で説明する。

【００２０】この発明は、上記知見に基づきなされたものであって、下記を特徴とするものである。

【００２１】請求項１記載の発明は、表面に硬質皮膜が形成された、超塑性金属からなることに特徴を有するものである。

【００２２】請求項２記載の発明は、前記硬質皮膜は、傾斜分布組成を有することに特徴を有するものである。

【００２３】請求項３記載の発明は、前記硬質皮膜は、ＴｉＮからなり、前記ＴｉＮ濃度は、前記硬質皮膜の表層から内部に向って低下しており、前記超塑性金属は、Ｔｉ合金からなることに特徴を有するものである。

【００２４】請求項４記載の発明は、前記Ｔｉ合金は、Ａｌ：４から５％、Ｖ：２．５から３．５％、Ｆｅ：１．５から２．５％、Ｍｏ：１．５から２．５％（以上、Ｍａｓｓ％）、残部：実質的にＴｉからなることに特徴を有するものである。

【００２５】請求項５記載の発明は、前記硬質皮膜は、Al_2O_3からなり、前記Al_2O_3濃度は、前記硬質皮膜の表層から内部に向って低下しており、前記超塑性金属は、Ａｌ合金からなることに特徴を有するものである。

【００２６】請求項６記載の発明は、基板の表面を加工することによってマイクロ部品用金型の原型を調製し、次いで、前記基板との反応を阻止する硬質皮膜を前記原型の表面に形成し、そして、超塑性金属と前記皮膜とを拡散接合させることにより、前記超塑性金属に前記皮膜を介して前記原型を転写することに特徴を有するものである。

【００２７】請求項７記載の発明は、前記硬質皮膜の硬質形成物質の濃度を、前記基板表面から超塑性金属側に向けて低下させることに特徴を有するものである。

【００２８】請求項８記載の発明は、前記基板は、Ｓｉからなり、前記超塑性合金は、Ｔｉ合金からなり、そして、前記硬質形成物質は、ＴｉＮからなることに特徴を有するものである。

【００２９】請求項９記載の発明は、前記基板は、Ｓｉからなり、前記超塑性合金は、Ａｌ合金からなり、そして、前記硬質形成物質は、Al_2O_3からなることに特徴を有するものである。

【００３０】請求項１０記載の発明は、前記基板の表面に、フォトリソグラフィー法によって前記原型のレジストパターンを形成し、そして、前記レジストパターン以外の前記基板の表面部分をエッチングにより所定深さに除去することによって、前記原型を調製することに特徴を有するものである。

【００３１】請求項１１記載の発明は、前記Ｔｉ合金は、Ａｌ：４から５％、Ｖ：２．５から３．５％、Ｆｅ：１．５から２．５％、Ｍｏ：１．５から２．５％（以上、Ｍａｓｓ％）、残部：実質的にＴｉからなることに特徴を有するものである。

【００３２】

【発明の実施の形態】次に、この発明によるマイクロ部品用金型の製造方法の一実施態様を、図面を参照しながら説明する。

【００３３】図１は、フォトレジストが塗布されたＳｉ基板を示す断面図、図２は、露光工程を示す断面図、図３は、現像工程を示す断面図、図４は、エッチング工程を示す断面図、図５は、原型の表面へのＴｉＮ膜の形成工程を示す断面図、図６は、転写工程を示す断面図、図７は、この発明によって製造されたマイクロ部品用金型を示す断面図、図８は、射出成形工程を示す断面図、図９は、拡散接合の説明図である。

【００３４】超塑性を有する金属としては、Ｔｉ合金、Ａｌ合金、Ｃｕ合金、Ｍｇ合金等があり、その中で、マイクロ部品用金型として使用する際、腐食性の液体やガスに晒される場合があるために、耐食性に優れたＴｉ合金あるいはＡｌ合金が特に望ましいが、これ以外の上記他の超塑性を有する金属であっても良い。

【００３５】Ｔｉ合金で超塑性を示す材料として、Ｔｉ－６Ａｌ－４Ｖ合金があるが、加工温度が８７５から９５０℃と高温であり、設備上の制約が多い。例えば、高温加工に耐え得る高温強度を有する高価な加工治具が必要であり、治具の寿命が短い等の制約がある。

【００３６】これに対して、Ｔｉ－４．５Ａｌ－３Ｖ－２Ｆｅ－２Ｍｏ合金は、７００℃程度の温度で超塑性を示し、設備上も使用しやすい。また、この合金の最大伸びも２０００％を程度と他の材料に比べて非常に高く、従って、より精密な部品の製造に適している。具体的には、不活性ガス雰囲気中において、この合金の（β変態点－２００℃）から（β変態点－５０℃）の温度範囲内で$10^{-1}S^{-1}$から$10^{-2}S^{-1}$の範囲内の歪速度で塑性加工を行なう。

【００３７】上記Ｔｉ合金を使用して、マイクロ部品用金型を製造するには、先ず、図１に示すように、Ｓｉ基板１の表面にフォトレジスト２を所定の厚さに塗布する。

【００３８】次いで、図２に示すように、マスク３を介して光をＳｉ基板１の表面に照射して、マスクパターンをフォトレジスト２に転写する。

【００３９】次に、図３に示すように、光が当たった部分のフォトレジスト２Ａを溶剤によって除去する。

【００４０】次に、図４に示すように、イオン照射等のドライエッチングによりＳｉ基板１の表面を所定深さにエッチングして、Ｓｉ基板１の表面にレジストパターンの溝４を形成する。

【００４１】上記溝４の幅（Ｗ）は、用途により異なるが５０ｎｍから２００μｍの範囲内である。エッチング法は、溶剤によるウェットエッチングでも良いが、ドライエッチングの方がより高精度なエッチングが行なえる。

【００４２】次に、図５に示すように、残存するフォトレジスト２を除去し、表面にＴｉＮ膜５を、例えば、スパッタリングにより所定の厚さに蒸着させて、マイクロ部品用金型の原型６を調製する。ＴｉＮ膜５は、図９に示すように、スパッタリング条件を調整して、後述するチタン合金と接する側の表層に向ってＴｉＮ濃度が低くなり、前記チタン合金と接する表面は、実質的に純Ｔｉとなる傾斜分布組成となるように形成する。

【００４３】次に、図６に示すように、表面にＴｉＮ膜５が形成された原型６を基台７上に乗せ、原型６上に、例えば、金型用素材としてのチタン合金（Ｔｉ－４．５％Ａｌ－３％Ｖ－２％Ｆｅ－２％Ｍｏ）８を乗せる。そして、ヒーター９によりチタン合金８を加熱しながら加圧して、チタン合金８に、ＴｉＮ膜５を介して原型６を転写する。上記組成のチタン合金８は、上述のように、約７００℃に加熱すると、超塑性が出現し、特異な延びを示す。この結果、チタン合金８は、原型６の溝４内に細部まで入り込むので、原型６に忠実なレプリカ、即ち、チタン合金製マイクロ部品用金型１０が製造される。

【００４４】なお、上記転写に際して、Ｔｉ合金と純Ｔｉとは拡散接合性に優れることから、図９に示すように、Ｔｉ合金とＴｉＮ膜とは拡散接合により強固に接合する。この結果、表面に高硬度のＴｉＮ膜５が形成された、繰り返し使用や押出し成形等の加工に耐え得るＴｉ合金製金型１０が製造される。しかも、超塑性加工条件と拡散接合条件とは重複するので、転写と拡散接合が一工程で行なえる。さらに、基板に硬質のＴｉＮ膜やAl_2O_3膜を形成させてからＴｉ合金等の金型素材を押し込むので、より高精度でｎｍオーダーの微細構造の転写が可能となる。

【００４５】この金型１０を使用して、プラスチック製マイクロ部品を製造するには、図８に示すように、表面に高硬度のＴｉＮ膜５が形成された金型１０を押出し成形型１１内にセットし、プラスチックを射出成形すれば、同図に示すように、上記幅（Ｗ）寸法の溝１２Ａが形成されたマイクロ部品１２を成形することができる。

【００４６】以上は、金型用素材として超塑性を有するチタン合金を使用した場合であるが、例えば、超塑性を有するＡｌ合金を使用する場合には、原型６の表面にAl_2O_3膜を形成する。この際、Ａｌの酸化条件を調整して、表層に向ってAl_2O_3濃度が低くなり、表層は、実質的に純Ａｌとなる傾斜分布組成となるように形成すれば、超塑性を有するＴｉ合金を使用した場合とほぼ同様に、製造コストが安価で且つ高い精度を有し、しかも表

面の硬度が高いマイクロ部品用金型を製造することができる。

【００４７】

【発明の効果】以上のように、この発明によれば、Ｓｉ等の基板の表面をフォトリソグラフィー法およびドライエッチング法等により加工することによって、マイクロ部品用金型の原型を調製し、次いで、前記原型の表面に、深さ方向に傾斜分布組成を有するＴｉＮ等の硬質膜を形成し、そして、超塑性を有するチタン合金等の金属に前記原型を転写することによって、製造コストが安価で且つ高い精度を有し、しかも表面の硬度が高い、分光デバイス、エンコーダー用スケール等のマイクロ部品用金型を容易に製造することができといった有用な効果がもたらされる。

【図面の簡単な説明】

【図１】フォトレジストが塗布されたＳｉ基板を示す断面図である。

【図２】露光工程を示す断面図である。

【図３】現像工程を示す断面図である。

【図４】エッチング工程を示す断面図である。

【図５】原型の表面へのＴｉＮ膜の形成工程を示す断面図である。

【図６】転写工程を示す断面図である。

＊【図７】この発明によって製造されたマイクロ部品用金型を示す断面図である。

【図８】射出成形工程を示す断面図である。

【図９】拡散接合の説明図である。

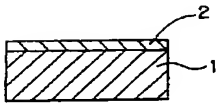
【図１０】回折格子を形成した分光デバイスを示す部分断面図である。

【図１１】エンコーダー用スケールを示す部分断面図である。

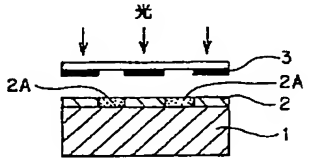
【符号の説明】

１：Ｓｉ基板
２：フォトレジスト
２Ａ：光が当たった部分のフォトレジスト
３：マスク
４：溝
５：ＴｉＮ膜
６：マイクロ部品用金型の原型
７：基台
８：チタン合金
９：ヒーター
１０：マイクロ部品用金型
１１：成形型
１２：マイクロ部品
＊　１２Ａ：溝

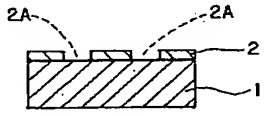
【図１】



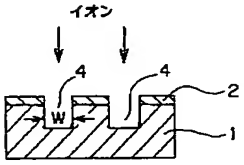
【図２】



【図３】



【図４】



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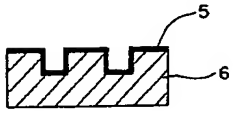
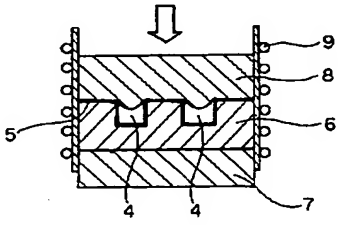


【図６】



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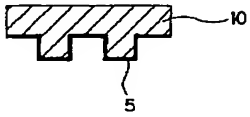

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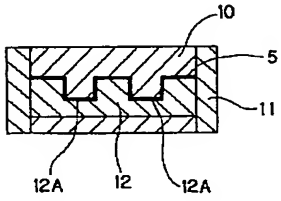
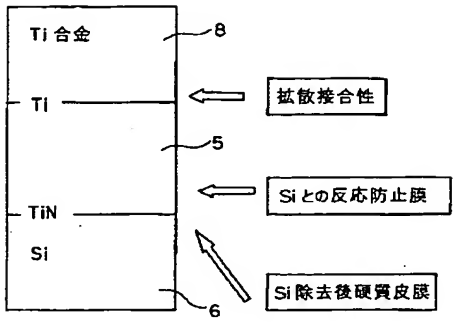


【図１０】

【図１１】

【図９】



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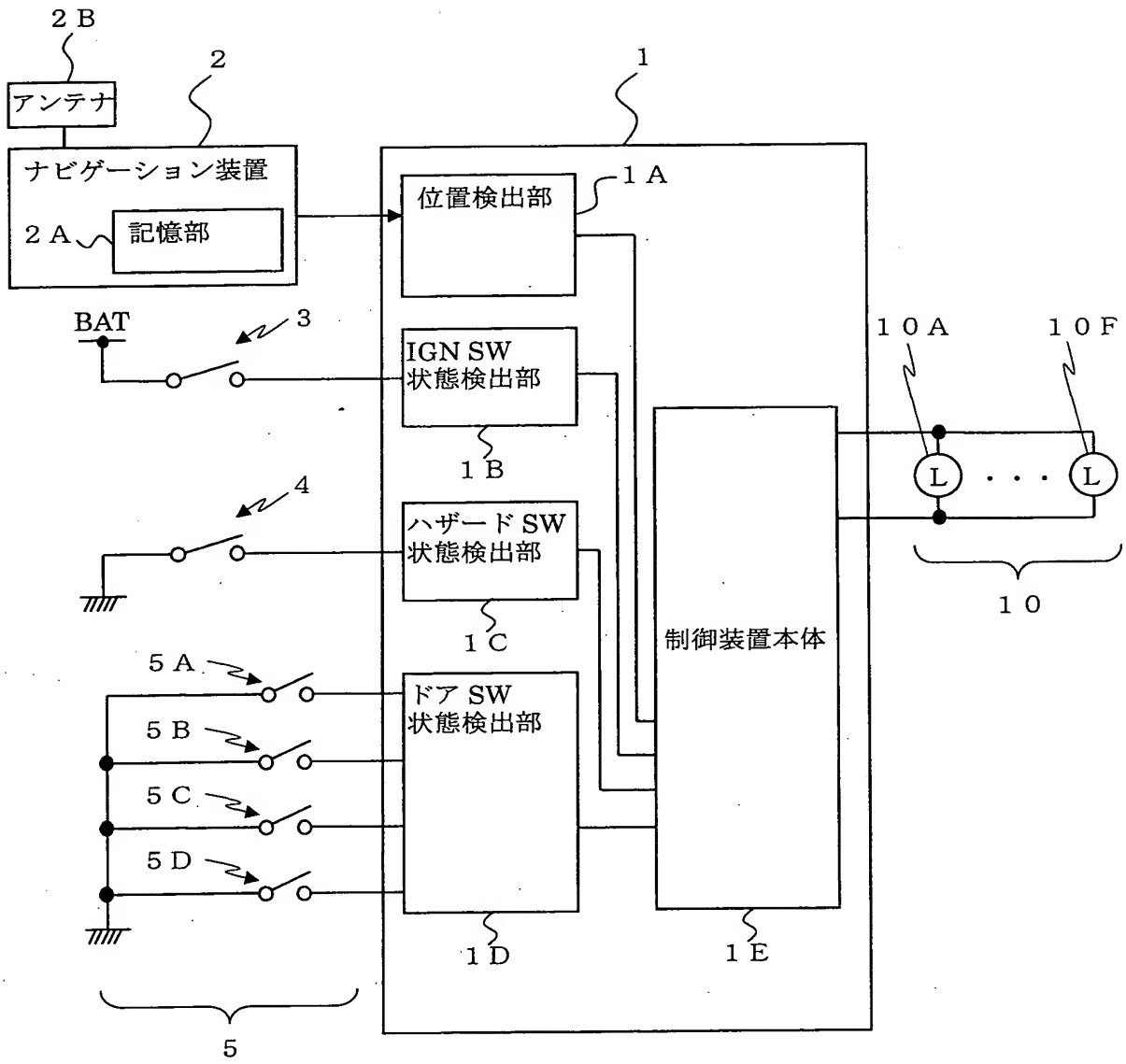
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１Ａ
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